

1 CLAIMS

1. A drill pipe storage apparatus comprising:
a pipe storage bin,
horizontal pipe support members disposable in the bin at plural spaced stations
along the length of the bin for individually supporting plural horizontal lengths of drill pipe in
an array of plural vertically spaced layers and of plural lengths of drill pipe in each layer, and
selectively operable drive mechanisms connected to the pipe support members and
operable to move the members individually between deployed positions in which the support
members are in the array and horizontal retracted positions in which the support members are
removed from the array.

2. Apparatus according to claim 1 in which the pipe support members are arranged
to support the pipe lengths without subjecting any pipe length to loads due to pipe and support
members thereabove in the array.

3. Apparatus according to claim 1 in which the lowermost support member at each
station as carried on a bin base, and each other support member at the station when disposed in
the array is engaged with and supported on the support member below it.

4. Apparatus according to claim 3 in which the pipe support members when engaged
with each other are keyed against relative movement in directions along pipe lengths supported
in the bin.

5. A drill pipe storage apparatus comprising:
a pipe storage bin,
horizontal pipe support members disposable in the bin at plural spaced stations
along the length of the bin for individually supporting plural horizontal lengths of drill pipe in
an array of plural vertically spaced layers and of plural lengths of drill pipe in each layer, the
lowermost support member at each station being carried on a bin base, and each other support
member at the station when disposed in the array being engaged with and supported on the
support member below it, each pipe support member defining in an upper part thereof a plurality
of upwardly open notches sized in cooperation with the vertically adjacent contour of the support
member thereabove in the array to receive in each notch a respective pipe length of selected
diameter without contact of the pipe length with the support member directly thereabove, and
selectively operable drive mechanisms connected to the pipe support members and
operable to move the members individually between deployed positions in which the support

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1 members are in the array and retracted positions in which the support members are removed from
the array.

5 6. Apparatus according to claim 5 in which the pipe receiving notches have
substantially straight sloping sides.

10 7. A drill pipe storage apparatus comprising:
a pipe storage bin,
horizontal pipe support members disposable in the bin at plural spaced stations
along the length of the bin for individually supporting plural horizontal lengths of drill pipe in
an array of plural vertically spaced layers and of plural lengths of drill pipe in each layer, and
selectively operable drive mechanisms connected to the pipe support members and
operable to turn the support members about vertical axes located outside the array to move the
members individually between deployed positions in which the support members are in the array
and retracted positions in which the support members are removed from the array.

15 8. Apparatus according to claim 7 in which the drive mechanisms are operable to lift
and lower the pipe support members.

20 9. Apparatus according to claim 7 in which the drive mechanisms include at each
station a rotatable vertical shaft with which is associated a group of pipe support members, each
support member in the group having an end frame through which the shaft rotatably passes, a
coupling selectively engageable between each pipe support member and the shaft for securing
the shaft from rotation relative to the pipe support member, and a shaft drive operable for rotating
the shaft a selected amount in either direction about its axis.

25 10. Apparatus according to claim 9 in which the shaft is axially movable through each
pipe support member, each coupling is operable for securing the associated pipe support member
from axial motion of the shaft relative thereto, and the shaft drive is operable for raising and
lowering the shaft a selected amount.

30 11. Apparatus according to claim 9 including a holder for each support member with
which the support member is engageable in its retracted position.

35 12. Apparatus according to claim 9 in which the pipe support members at each station
comprises two groups of movable support members, alternate support members being members
of a respective group with which is associated a respective one of a pair of vertical shafts.

13. Apparatus according to claim 12 in which the shafts at each station are disposed at a common side of the bin.

14. Apparatus according to claim 12 in which the pipe support members in one group have retracted positions in which they extend in one direction from the station substantially parallel to the array, and retracted pipe support members in the other group extend in an opposite direction from the station substantially parallel to the array.

15. Apparatus according to claim 12 in which the deployed positions of the pipe support members at each station are in a common vertical plane disposed transversely of the array, and each support member above the lowermost one is supportively engaged with the support members below it.

16. A drill pipe storage apparatus comprising:
a pipe storage bin stationary relative to a place of pipe use
horizontal pipe support members disposable in the bin at plural spaced stations along the length of the bin for individually supporting plural horizontal lengths of drill pipe in an array of plural vertically spaced layers and of plural lengths of drill pipe in each layer,
selectively operable drive mechanisms connected to the pipe support members and operable to move the members individually between deployed positions in which the support members are in the array and retracted positions in which the support members are removed from the array, and a pipe lifter disposable above the array and operable to move individual pipe lengths in a horizontal attitude between the array and a transfer position laterally of the array.

17. Apparatus according to claim 16 in which the pipe lifter comprises a bridge crane spanning the length of the bin and movable transversely relative to the bin.

18. Apparatus according to claim 16 in which the pipe lifter includes a plurality of controllable magnetic pipe lift units engageable with a pipe length at spaced locations along the length.

19. Apparatus according to claim 18 in which each pipe lift unit comprises plural permanent magnets and a selectively operable degausser.

20. Apparatus according to claim 18 in which each pipe lift unit includes a backup mechanical holder selectively engageable with and releasable from a pipe length.

1 21. Apparatus according to claim 18 in which the pipe lift units are supported on a common carrier.

5 22. Apparatus according to claim 21 in which the bridge crane has a stowed position spaced laterally from the bin in which pipe lift units are securable to structures at a lower exterior portion of the bin.

10 23. Apparatus according to claim 21 in which the common carrier for the pipe lift units is movable vertically relative to the bridge crane via a plurality of column members drivable vertically of the crane.

15 24. Apparatus according to claim 23 in which the column members have vertically spaced guides in the bridge crane arranged to constrain the column members to motion substantially only normal relative to the crane.

20 25. Apparatus according to claim 16 in which the bin is spaced in a direction substantially parallel to the length of the bin from a place of use of pipe lengths, and including a pipe delivery mechanism for moving pipe in a horizontal attitude between a transfer position adjacent the bin and the place of pipe use, the pipe delivery mechanism includes a track extending from the transfer position toward the place of pipe use.

25 26. Apparatus according to claim 25 including an elongate carriage drivable in each of two opposite directions along the track to and from the transfer position, the carriage having a length adequate to support a pipe length in alignment therewith at one end of the pipe length and at a location along the pipe length near its other end.

30 27. Apparatus according to claim 26 including a cart drivable in each of two opposite directions along the length of the carriage, the cart defining an upwardly open receptacle for receiving and bearing the one end of a pipe length supported on the carriage.

35 28. Apparatus according to claim 27 including a pipe support roller mounted at the end of the carriage nearest the place of pipe use for rotation about a horizontal axis.

 29. Apparatus according to claim 28 in which the roller has a larger diameter in its ends than between its ends.

1 30. Apparatus according to claim 28 including a selectively operable lift mechanism mounted between the roller and the carriage operable for controllably raising and lowering the roller relative to the carriage.

5 31. Apparatus according to claim 30 in which the roller lift mechanism is disposed on the carriage out of the path of the cart along the carriage.

10 32. Apparatus according to any one of claims 25-31 in which the place of pipe use is a well drilling facility which includes a drilling operations platform.

15 33. Apparatus according to claim 32 in which the track is substantially coplanar with the drilling operations platform.

20 34. Apparatus according to claim 32 in which the drilling facility is located on a floatable offshore drilling structure.

25 35. Apparatus according to claim 34 including a second pipe storage bin disposed in proximate parallel relation to the transfer position.

30 36. A drill pipe storage and handling apparatus for a well drilling rig comprising:
a track extending from one end adjacent the drilling rig to an opposite end remote from the rig,

35 an elongate carriage adapted to travel along the track and to receive a length of drill pipe disposed longitudinally with respect to the track and to support a received pipe length at spaced locations therealong,

40 a pipe storage bin disposed laterally of one end of the track including horizontal pipe support members cooperatively configured for individually supporting plural lengths of drill pipe in an array of plural vertically spaced layers of pipe and plural length of pipe in each layer, the pipe support members above the bottom layer being indexable between deployed positions in and transversely of the array and retracted positions outside the array,

45 a moveable pipe lifter disposable above the bin operable to move individual pipe lengths between the array and the carriage.

50 37. Apparatus according to claim 36 in which the carriage includes a pipe lifter at its end adjacent the drilling rig operable to lift the adjacent end of a received pipe length a selected distance above the carriage.

38. Apparatus according to claim 37 in which each pipe length has a pin end and a box end, the pipe lengths are disposed in the array with their pin ends remote from the drilling rig, and including a cart movable along the carriage adapted for supporting the pin end of a received pipe length.

39. Apparatus according to claim 38 in which the carriage is drivable along the track, and the cart is drivable along the carriage.

40. Apparatus according to claim 36 in which the track and the carriage are common to and are disposed between a pair of similar bins.

41. Apparatus according to claim 40 in which the pipe lifter is operable to move pipe lengths between either bin and the carriage.

42. A method of storing oil and gas well drill pipe comprising the steps of horizontally disposing a selected number of pipe lengths, as a first bottom layer thereof, individually in upwardly open notches in the upper extents of a set of stationary pipe supports disposed transversely of the pipe lengths at stations spaced along the lengths, and horizontally disposing further numbers of pipe lengths in further similarly notched pipe support sets placed at each station atop the supports therebelow to create a stationary array of plural layers of plural numbers of pipe lengths, and raising and lowering individual pipe lengths directly from above and to receiving notches in the pipe supports.

43. The method according to claim 42 including defining the support members so that each pipe length in the array makes contact only with the surfaces of the upwardly open notches of the pipe supports immediately below it in the array.

44. The method according to claim 42 including the further step of moving each set of pipe supports to retracted horizontal positions out of the array upon removal of all pipe lengths from the layer supported by that set to expose the next lower layer in the array, and moving the next upper set of supports into deployed positions in the array on filling a pipe length layer in the array.

45. The method according to claim 44 in which moving the pipe supports from deployed positions to retracted positions includes raising the deployed supports out of contact with the supports therebelow in the array, swinging each raised support horizontally about an axis at an end of the support, and lowering the raised and swung supports into holders therefor located outside the array.

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1 46. The method according to claim 45 in which moving the pipe supports from retracted positions to deployed positions includes performing the reverse of each of the operations described in claim 45 in reverse sequence.

5 47. The method according to claim 42 in which raising individual pipe lengths from the pipe supports includes engaging a pipe length from above at spaced locations along the length by a plurality of magnetic lift heads, and raising the lift heads in substantial unison.

10 48. The method according to claim 42 in which lowering individual pipe lengths to the pipe supports includes horizontally supporting a pipe length from above via a plurality of magnetic lift heads at spaced locations along the pipe length, lowering the lift heads in substantial unison to place the pipe length in aligned notches in a set of pipe supports, and nulling the magnetic fields of the lift heads.

15 49. A method of storing oil and gas well drill pipe comprising the steps of horizontally disposing a selected number of pipe lengths, as a first bottom layer thereof, individually in upwardly open notches in the upper extents of a set of pipe supports disposed transversely of the pipe lengths at stations spaced along the lengths, and horizontally disposing further numbers of pipe lengths in further similarly notched pipe support sets placed at each station atop the supports therebelow to create an array of plural layers of plural numbers of pipe lengths, and raising and lowering individual pipe lengths directly from and to receiving notches in the pipe supports, raising a pipe length from its pipe supports including moving the pipe length in a horizontal attitude from the array to a state of support on a carriage movable along a path laterally from, adjacent to and parallel to the array, the carriage supporting the pipe length at spaced locations
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25 along the pipe length.

30 50. The method according to claim 49 including raising an end one of the locations of carriage support of the pipe relative to the carriage upon movement of the carriage to a selected place displaced from the array, the selected place being associated with removal of the pipe length from the carriage.

35 51. The method according to claim 49 in which the carriage has two locations of support of a pipe length disposed thereon, one of which is raisable relative to the carriage, the other of which is movable along the carriage and is adapted to support an end of the pipe length.

 52. A method for storing, handling, and moving drill pipe in association with a well drilling rig having a drilling operations floor, the method comprising the operations of:

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- 1 lifting a stand of drill pipe directly from an individual horizontal storage position
in an array of stand storage positions,
placing the lifted stand on a carriage arranged to support the placed stand at spaced
locations along its length,
5 moving the carriage towards the floor to place one end of the carriage at the floor,
elevating the one end of the placed stand above its placed position on the carriage
as the carriage nears the floor, and
hoisting the stand via the one end thereof to a vertical position above the floor while
movably supporting the other end of the stand on the carriage.

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53. The method according to claim 52 in which the elevating operation includes raising
the location of carriage support of the placed stand which is nearest the one end of the stand.

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